THE ADVANTAGES OF SENSOR CONTROL SYSTEMS VENTIL-INDUCTION ENGINE, AS THE GUARANTEE OF ITS TROUBLE-FREE WORK AT HIGHER SPEEDS ROTATIONS

Denisenko Viktor Ivanovich[1], Filippov Ivan Igorevich[2]
[1] Doctor Sc., Prof., Ekaterinburg, Russia, v.i.denisenko@urfu.ru
[2] Post-graduate student, Ekaterinburg, Russia, Urallife@mail.ru

Abstract - In work the advantages of the sensor control system of the gate-inductor motor with ceramic insulation over the sensorless control system are considered.

Keywords - ***valve-inductor motor, sensor control system, rotor position sensor.***

I.INTRODUCTION

In modern engineering, it is possible to produce hybrid models of electric motors where the power part is aligned with the rotor position sensor and the control controller sequentially switches the power semiconductor switches to supply current to the motor windings. The Department of Electrical Machines together with its partners Innovative Innovation Center Electromekhtekhnok URFU and the Department of Rare Metals and Nanomaterials URFU and JSC SverdNIIHimmash produced prototypes of valve-inductor motors (VID), this type of electric motor is a rather complicated electromechanotron system, an integral part of energy conversion in which is a control system with rotor position sensors. The VID is used for recycling in high-radiation environments where the use of sensitive electronic components in rotor position sensors is not possible.

II.THE PROPOSED OPTION

In the ITC "Electromechanica" together with "Sapphire" LLC, three versions of the design of the VID, with a power of 2 kW and a nominal speed of 1000 rpm [1,2] have been developed. However, further increase in the rotational speed is limited by the feature of the sensorless control system, when a low-current interrogation pulse follows the power pulse. The current of the power pulse still does not have time to decay, while the semiconductor key is opened to pass the current of the low-current pulse, so the error in measuring the position of the rotor does not allow the controller to "understand" the current position of the rotor, and therefore it becomes impossible to determine at what time the power pulse should be applied . In such a situation, a power pulse can be delivered untimely and, as a consequence, brake the rotor. Such technical limitations of the sensorless control system made it necessary to continue scientific research using the VID sensor control.

A sensor that can be used in a VID is a reductosin, an induction analog position sensor. Structurally, it represents a rotating transformer (Figure 1)

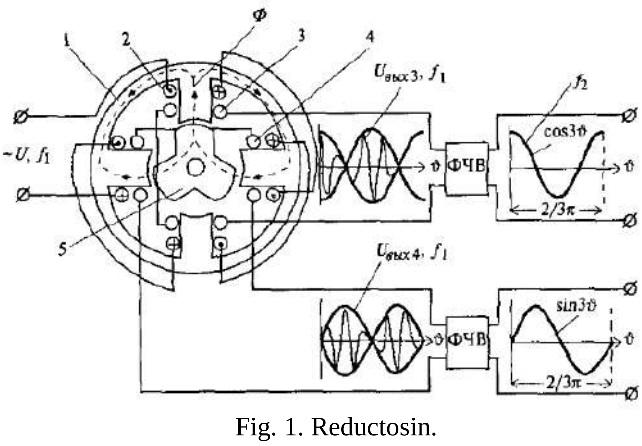

Fig. 1. Reductosin.
1 - Fired stator; 2 - Excitation winding; 3 - The first phase; 4 - The second phase; 5 - Fused rotor

Reductosin has a stranded stator with excitation winding consisting of series-connected coils forming a pole system. On the pole protrusions of the stator there are also two phases of the output (signal) winding, shifted in space by 90 degrees. Each of the phases consists of two coils connected in series. The excitation winding is fed by an alternating voltage of frequency f, which induces a transformer EMF in both phases of the secondary signal winding. In this case, the magnitude of the induced EMF depends on the angular position that the rotor occupies with respect to one or another phase. With a change in the angular position of the rotor, the magnetic conductivity of the air gap changes, and hence the coefficient of mutual induction between the coils of the excitation winding and the coils of the phases of the signal winding. If the conductivity of the air gap is changed according to the harmonic law, depending on the rotor rotation angle, then the amplitude of the output voltage of the signal windings will change according to the same law.

In Figure 1, the pulsating flow Φ (the instantaneous direction and flow distribution is shown) induces EMF in the phase coils. In this particular position of the rotor, the entire flow adheres to the upper coil of the first phase (winding 3 of Figure 1) and its EMF is maximal. The flow Φ also adheres to the coils of the second phase (winding 4 of Fig. 1). Each coil is connected to half of the flow Φ, and these flow components are directed in different directions. Since the coils are connected according to, their resulting EMF is zero. If the rotor is rotated counterclockwise, the voltage amplitude of the first phase (winding 3 of Figure 1) will decrease according to the cosine law, and the amplitude of the second phase (winding 4 of Figure 1) will increase according to the law of the sine. Phase-sensitive rectifiers PFV allocate an envelope of output voltages. Thus, the output of the first phase will receive a voltage that varies according to the cosine law, and at the output of the second phase - according to the law of the sine.

CONCLUSIONS

In conditions of high radiation exposure, where replacement of out-of-service equipment always entails simple costly production, and as a result leads to lost profits, a reliable design solution is needed to use the VID, which may be a reductosin that does not have electronic elements. All reductosin windings should be covered with the same type of ceramic insulation as the stator winding of the VID. The high-pass frequency filter element containing the electronic components must be taken out of the structure into the zone of reduced radiation background.

The power part of the VID together with the rotor position sensor will operate directly in the zone of increased radiation, while control and power wires using the cable with ceramic insulation will be withdrawn from this zone, where they will be connected directly to the control controller and power keys.

In the case of the sensor system for determining the rotor position, the VID becomes possible to reach the rotor speeds required by the industrial sector up to 1500 rotations per minute or even higher, since the processor will be able to parallelize its work and to make answer to the sensor, regardless of the time, spent on growth and damping of the control signals.

REFERENCES

[1]. Gayfutdinov A. R. Radiation-resistent vaive-inductor type motor as a part of technological installation for recycling nuclear industrial waste / A. R Gayfutdinov., V. I. Denisenko, A. T. Plastun, M. V. Baranov, A. R. Beketov // “Electrical Engeneering, Energy, Mechanical Engeneering – EEM 2014.” – 2014, Novosibirsk, – pp. 111–115, DOI: 10.4028/www.scientific.net/AMM.698.111.

[2]. Beketov, A.R.; Designing and testing a system of controlling a switched reluctance motor with ceramic insulation, using no pickups in Control and Communications (SIBCON) / A. R. Beketov, V. I. Denisenko, A. N. Moiseichenkov, A. T. Plastun, D. A. Lukonin, A. R. Shaikhiev, V. K. Sanin // International Siberian Conference, – 2015 – pp.1-3 doi: 10.1109/ SIBCON.2015.7147149 URL: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7147149&isnumber=7146959

[3]. Denisenko V.I. Sensorless determination of the rotor position of the gate-inductor motor / V.I. Denisenko, A.T. Plastun, A.D. Petrushin, M.V. Chavichalov // Izvestiya Vuzov: Electromechanics, №5. 2013. Стр. 34-37. ISSN 0136-3360.

[4]. Ovchinnikov IE Ventilated electric motors and drive on their basis / IE Ovchinnikov // Course of lectures. - spb .: CROWN-Vek, 2006. - 336 p .: ill. ISBN 5-7931-0344